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DRC-1339 avicide fails to protect ripening sunflowers

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From 20 August to 19 September 1993 and 1994, we assessed the effects of treating ripening sunflower fields with DRC-1339-treated rice baits on blackbird (Icterinae) damage to sunflower fields found within ≤ 3.2 km of blackbird roosts. The number of blackbirds ($\bar{x}$ = 18,943 ± 1,888) using roosts centered within the treated and untreated test areas were similar (P = 0.432). The number of blackbirds using sunflower fields in the test areas did not vary among days after treatment (P = 0.538) or between treated and untreated areas (P = 0.203, averaging 3203 ± 361). The percentage of sunflower damage did not differ (P = 0.736) between treatments ($\bar{x}$ = 2.3 ± 0.6%). It appears broadcasting DRC-1339-treated rice baits in ripening sunflower fields does not reduce local blackbird populations or sunflower damage. Published by Elsevier Science Ltd.

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Recent surveys of sunflower producers in North Dakota and South Dakota showed that blackbird (Icterinae) damage to sunflower remains a major production problem (Lamey *et al.*, 1993; North Dakota Agricultural Statistics Service, 1995). In 1994, 601 of 1035 procedures requesting assistance from the US Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control reported average losses of 9.1%, valued at US$4130 per year (North Dakota Agricultural Statistics Serivce, 1995). Eighty-two percent of these producers were supportive of the development of an avicide to reduce damage by blackbirds (North Dakota Agricultural Statistics Service, 1995).

In 1985, Cummings, Schafer and Cunningham (1990) failed to reduce blackbird populations in three small ripening sunflower fields (≤12 ha) with DRC-2698-treated (*N*-(3-chloro-4-methylphenyl)acetamide) sunflower meats and cracked corn. Despite these results, sunflower producers are seeking the development of DRC-1339 (3-chloro-4-methylbenzenamine) (Lilleboe, 1995), a slow-acting (1–3 days) toxicant, with mode of action and lethal effects similar to DCR-2698 (Schafer, 1984), for reducing resident and migratory blackbird populations. DRC-1339 is available as a concentrate (98% active ingredient, P.M. Resources, St. Louis, Missouri, USA) that may be formulated with various food items or is available in pellet form as Starlicide Complete (0.1% active ingredient, Purina Mills, Inc., St. Louis, Missouri, USA). Currently, DRC-1339-treated rice bait is used in Louisiana to successfully reduce blackbird populations responsible for damaging sprouting rice (Glahn and Wilson, 1992). The objective of this research was to test the efficacy of DRC-1339 for suppressing blackbird damage to ripening sunflower in North Dakota.

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Materials and methods

Study area

In 1993, the study area was located in Grand Forks and Nelson counties, in northeastern North Dakota. In 1994, the study area was located in Dickey, Forman, and LaMoure counties in southeastern North Dakota. Both study areas were characterized by the presence of many shallow-basin wetlands dominated by emergent vegetation preferred by roosting blackbirds (Linz *et al.*, 1995a). Of about 770,000 ha of cropland in those counties, 15% was planted to sunflower and 85% was planted to small grains and corn (North Dakota Agricultural Statistics Service, 1994).

Bait formulation

The product used in this experiment was DRC-1339 98% technical concentrate (CAS No. 7745–89–3). In North Dakota, caged blackbirds captured in late summer tend to prefer brown rice over dried cracked corn and sunflower meats (Linz *et al.*, 1995b). Thus, 2% rice baits were formulated by mixing 11.3 kg of brown rice ($\bar{x}$ mass = 0.02 ± 0.004 SD g grain^{-1}; Linz *et al.*, 1995b) with 0.23 kg powdered DRC-1339 and 0.08 kg Alcolec S (American Lecithin Co., Danbury, CT, USA). The 2% treated rice baits and untreated rice were mixed at a 1:25 (wt/wt) ratio and used within 24 h.

Baiting in sunflower fields

Sunflower fields within 3.2 km of 10 blackbird roosts were paired within locations (northeastern and southeastern North Dakota) and each set of sunflower fields within the pair randomly designated as either control or treated. The average distance between paired roosts was 28 ± 6 (SE) km, which was sufficient to minimize roost interchange (Linz *et al.*, 1991). Baiting commenced in August when blackbirds began roosting in wetlands and feeding in nearby sunflower fields. We treated one or two sunflower fields located within ≤1.6 km of the test roost used by at least 1000 blackbirds before treatment.

For treatment, each field was subdivided into three equal-sized strata. The location of the first bait lane was randomly selected, after that, the other two bait lanes were placed systematically equidistant from each other in the other two strata. A four-wheel drive all-terrain vehicle was used to create a bait lane approximately 1.5 m wide (one sunflower row) and the length of the sunflower field.

The all-terrain vehicle, mounted with a seed broadcaster, was used to pre-bait the bait lanes with untreated brown rice at a rate of 28.0 kg ha^{-1}. Sample plots were established along the three bait lanes in the three strata to determine bait consumption. Treated baits were applied at a rate of 28.0 to 56.0 kg ha^{-1} when birds began feeding on the prebait. The rate of bait consumption could not be determined because periodic heavy rains washed the bait particles out of the plots. Bait lanes were retreated after ≥0.6 cm of precipitation or when the bait began to discolor, indicating dissipation of the compound. Each field was baited about five times over an average of 12 days. The last baiting occurred by 19 September of each experiment year (1993 and 1994).

Estimating blackbird numbers

At least every two days, we counted blackbirds using the test roosts as they exited the wetlands at sunrise (Meanley, 1965), and counted blackbirds using each sunflower field located ≥3.2 km from the roosts between local sunrise and 4.5 h after sunrise. Both roosts and sunflower fields were censused in the same order throughout the study and usually by the same observer. Censuses were not conducted in the rain or in wind exceeding 32 km/h^{-1}.

Damage assessments

We conducted sunflower damage assessments 1–2 days before baiting selected fields and again after 19 September. At least 25% of the sunflower fields within ≥3.2 km of each test roost (including the baited fields) were selected for damage assessments. Two rows were randomly selected from each previously established baiting stratum and 48/1.5 m plots were proportionally distributed among the six rows based on the length of the rows. Plot interval was determined by dividing the total length of the row by the number of plots assigned to that row. The location of the first plot in each row was a randomly selected distance between the field edge and the first plot interval. The same rows were assessed before baiting and in late September. In 1993 and 1994, enumerators were trained by visually assessing percent damage on 230 and 521 sunflower heads, respectively, before conducting damage assessments (Dolbeer, 1975).

Statistical analyses

An arcsine transformation was used for the difference in proportion of sunflower damage between pre- and post-treatment damage assessments and a square root transformation was used for the blackbird numbers to normalize the data before conducting statistical analyses. One-way analyses of variance (ANOVA) and repeated measures (RMANOVA) were used to test the null hypotheses of no treatment effects within pre- and post-treatment periods (Cody and Smith, 1991), respectively, for the following hypotheses: (i) the numbers of blackbirds using the reference roosts and roosts near treated fields did not differ; and (ii) similar numbers of blackbirds were using sunflower fields surrounding reference roosts and roosts near treated fields. The alpha level was set at 0.1 (*a priori*) for all statistical tests because resources were not sufficient to increase sample sizes (Tacha, Warde and Burnham, 1982).

Results

Roost counts

Before treatment, blackbird numbers were similar (ANOVA, $P = 0.245$) between reference roosts and roosts near treated fields ($\bar{x}$ = 18,343 ± 2034). Blackbird numbers did not vary ($P = 0.779$) between days after treatment or between reference roosts and roosts near treated fields ($P = 0.432$), averaging $\bar{x}$ = 18,943 ± 1888 (Table 1).

Blackbird numbers in sunflower fields

Before baiting, blackbird numbers were higher ($P = 0.033$) in sunflower fields near the treated fields ($\bar{x}$ = 4152 ± 634) than in reference fields ($\bar{x}$ = 2379 ± 476; *Table 2*). Blackbird numbers in sunflower fields were similar among days after treatment (RMANOVA, $P = 0.538$) and between reference fields and treated fields ($P = 0.203$), averaging $\bar{x}$ = 3202 ± 361. However, there was a significant interaction between days after treatment and treatment ($P = 0.023$) due to an increase in numbers of blackbirds using reference fields.

Damage assessments

Percent sunflower damage recorded during training ($P = 0.511$) was similar among the three enumerators in 1993 and five enumerators in 1994 ($P = 0.894$), average 42.8 ± 1.9% and 6.7 ± 0.5%, respectively. Thus, the enumerators were consistent regardless of damage levels.

In 1993 and 1994, the percentage of sunflower damage differed ($P = 0.050$) between pretreatment ($\bar{x}$ = 1.3 ± 0.4%) and post-treatment ($\bar{x}$ = 3.3 ± 1.1) assessments. The percentage of sunflower damage was

Table 1. Mean numbers (untransformed) of blackbirds using five pairs of roosts in August and September in northeastern (1993) and southeastern (1994) North Dakota near sunflower fields treated with DRC-1339 on rice baits or left untreated

Year	Replication	Roosts near treated fields		Reference roosts	
		Pretreatment*	Post-treatment†	Pretreatment*	Post-treatment†
		$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$
1993	1	25267	25103	14033	12476
1993	2	7057	7642	7866	4534
1994	3	18753	14008	13726	15413
1994	4	46590	45668	38344	38044
1994	5	34900	29183	22336	12833

*Blackbird numbers were similar (ANOVA, $P = 0.245$) between treatments
†Blackbird numbers were similar (RMANOVA, $P = 0.432$) between treatments

Table 2. Mean numbers (untransformed) of blackbirds using sunflower fields surrounding five pairs of roosts in August and September in northeastern (1993) and southeastern (1994) North Dakota near sunflower fields treated with DRC-1339 on rice baits or left untreated

Year	Replication	Treated fields		Reference roosts	
		Pretreatment*	Post-treatment†	Pretreatment*	Post-treatment†
		$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$
1993	1	5642	3711	2409	1413
1993	2	2951	2349	2097	4671
1994	3	2785	3285	2616	5568
1994	4	4017	2263	2533	3900
1994	5	6300	2531	–	2220

–, no pretreatment counts
*Blackbird numbers differed (ANOVA, $P = 0.033$) between treatments
†Blackbird numbers were similar (RMANOVA, $P = 0.203$) between treatments

Table 3. Percentage of sunflower (untransformed) damaged by blackbirds (Icterinae) in reference sunflower fields and sunflower fields treated with DRC-1339 grain baits surrounding five pairs of wetland roosts in northeastern (1993) and southeastern (1994) North Dakota

Year	Replication	Damaged (%)*	
		Treated	Reference
		$\bar{x}$	$\bar{x}$
1993	1	0.05	0.53
1993	2	0.21	3.93
1994	3	0.13	0.06
1994	4	1.54	5.11
1994	5	7.63	3.72

*Sunflower damage did not differ (RMANOVA, $P = 0.736$) between treatments

similar ($P = 0.736$) across replications between treatments ($\bar{x} = 2.3 \pm 0.62\%$) (*Table 3*).

Discussion

In this study, blackbirds were observed flying from the sunflower heads to the ground, where they appeared to be feeding, We searched one wetland located within 0.5 km of a baited field and found about 100 dead blackbirds. Necropsies of these birds showed gross pathologies (e.g., distended bladder, loose gizzard lining, whitish pericardial deposits) consistent with DRC-1339 poisoning, confirming that blackbird were eating treated rice baits. However, our data demonstrate that sufficient numbers of blackbirds were not killed to reduce the number of birds feeding in sunflower fields. Poor efficacy was probably due, in part, to (i) large numbers of new birds constantly migrating into the study area (Linz *et al.*, 1991); (ii) movement of blackbirds among roosts (Besser *et al.*, 1979; Linz *et al.*, 1991), and (iii) movement of birds among sunflower fields to the extent that predicting preferred feeding locations was difficult.

Additionally, blackbirds are difficult to lure away from ripening crops to baits on the ground (Cummings, Schafer and Cunningham, 1990; Snyder, 1961). In Louisiana, blackbirds readily feed on DRC-1339-treated brown rice broadcast on harvested rice fields during late winter and early spring, resulting in large numbers of dead birds (Glahn and Wilson, 1992). However, preferred alternative foods are not readily available for the birds at that time.

Sunflower growers in our study areas used legal bird harassment techniques (e.g., propane cannons, airplane hazing, shooting) (Linz *et al.*, 1993) to reduce bird damage in their fields. It was difficult to quantify the efficacy of these techniques; however, grower effort was assumed to be equal between reference and treated experimental sites. Harassment of the birds by growers could cause the birds to temporarily move to less preferred fields (Besser *et al.*, 1979). The low damage levels noted in this study and other recent studies conducted in high damage areas of North Dakota (Linz *et al.*, 1995a) may be the result of increasingly effective private and government blackbird dispersal techniques (Handegard, 1988; Huffman, 1992). On the other hand, sunflower damage shows a clumped geographic distribution (Hothem, DeHaven and Fairaizl, 1988; Lamey *et al.*, 1993), and areas receiving high levels of

damage can vary from year to year depending on the availability of acceptable roost sites (Linz *et al.*, 1995a).

Management implications

Blackbirds causing damage to ripening sunflower continues to be a particularly vexing production problem for about 15% of the growers in North Dakota (Lamey *et al.*, 1993; Lilleboe, 1995; North Dakota Agricultural Statistics Service, 1995). The bird's preference for ripening crops over dried grains broadcast on the ground is a dilemma that must be overcome before toxicants formulated with grain baits can be used effectively in late summer. The inability to predict daily feeding patterns of blackbirds that readily move from field to field will make effective baiting regimes difficult to implement. However, grain baits may be used effectively during winter (Glahn and Wilson, 1992) and spring migration when ripening crops are not available and birds are seldom harassed by growers. Currently, we are conducting experiments designed to assess the efficacy of baiting blackbirds as they migrate north through sunflower growing areas to their breeding grounds.

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